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[The following are translations of selected articles in the Russian-language monthly journal AVIATSIYA I KOSMONAVTIKA published in Moscow. Refer to the table of contents for a listing of any articles not translated.]

Air Forces Deputy on Progress in Improving Service Conditions

91UM0807A Moscow AVIATSIYA I KOSMONAVTIKA in Russian No 2, Feb 91 (signed to press 13 Feb 91) pp 2-3

[Interview with Air Forces First Deputy Commander-in-Chief Colonel-General Aviation Petr Stepanovich Deynekin by a correspondent of AVIATSIYA I KOSMONAVTIKA under the rubric "On the Occasion of Soviet Army and Navy Day": "A Time for Fundamental Solutions"]

[Text] *Our society is on the path of renewal today. That is an obvious fact. Most of us are convinced that there are no alternatives to revolutionary transformations. Something else is exceedingly important—the anthology of vital practical problems affecting not only "purely everyday life," but nationwide interests as well.*

The armed forces of the USSR, including the Air Forces, are performing their missions against a difficult social background. Yes, the army is being cut back. That is a painful process. What needs to be done under these conditions to see that the combat readiness of units and subunits is not reduced, and that the interests of the people in shoulder boards are protected? These and other questions concern fliers deeply. Our correspondent asked one of those who, figuratively speaking, is at the main aviation command post—Air Forces First Deputy Commander-in-Chief Colonel-General Aviation Petr Stepanovich Deynekin—to express his opinion on this score.

[Correspondent] Comrade Colonel-General, the chief criterion for the activity of the Air Forces, despite all the difficulties, remains high combat readiness against a background of a constant rise in flight safety as before. What must be undertaken first of all to see that criterion become a reality?

[Deynekin] The Air Forces high command is currently actively engaged in the optimization of the teaching process. The increase in the number of pilots per aircraft and, as a consequence, somewhat of a reduction in flying time have placed before us the harsh necessity of converting combat training from extensive methods to intensive ones. Every minute of flight time, in other words, should be utilized with maximum return and bring the greatest increase in the fighting proficiency of the fliers. The focus here is being placed on the quality of assimilation of the teaching programs.

Intelligent initiative and a creative approach to the realization of military reform are very important during this difficult period. One cannot simply sit and fold one's arms, waiting for all the answers to difficult questions to come from the center. The high command will do everything within its power. But the supervisors must themselves still analyze the prevailing situation and take the appropriate steps in operative fashion, with a regard for the specific conditions and the nature of the combat-training tasks being fulfilled. The stage of fundamental solutions has come for all of us. I believe that the Air Forces will come out of this difficult situation with honor. The main thing is not to give way to pessimism and depressed sentiments.

[Correspondent] The questions that are heard particularly often today include the level of basic amenities for Air Forces personnel. What can you say on that score?

[Deynekin] The problem of basic amenities for the troops—social, cultural and domestic—and social protections for the servicemen and members of their families is of course strained to the utmost. One frequently encounters the figure of 177,000 in the open press. That is how many are without apartments in the armed forces. The number has reached 36,000 for us in the Air Forces, of whom 6,000 are the families of flight personnel. The situation has moreover been aggravated by the appearance of refugees from the so-called "explosive" regions, as well as by the withdrawal of troops from the countries of Eastern Europe. And all of that is occurring under conditions of the depressing situation both in our economy and in the life of Soviet people.

I, however, do not share the doubts saying that the Soviet soldier will cease to serve the Fatherland and go over to the other side for a loaf of bread, as they say. The loyalty to the Motherland and selfless devotion of the Russian soldier has been forged for centuries, and he is accustomed to harsh days and misfortune. He will not let you down in today's difficult situation either. What is more, he even helps the people with the harvest, the development of the Non-Chernozem zone, the elimination of the consequences of natural disasters, the localization of ethnic conflicts and the delivery of supplies for humanitarian aid.

[Correspondent] What problems are now being solved, and how?

[Deynekin] First of all, we have directed 80 percent of the ceiling allocated to capital construction to basic amenities for the troops. Second, in some formations almost all the personnel have been provided with apartments. I would like to say something on this score. Our desire to provide apartments to the flight personnel first of all is not finding support or understanding among all aviation personnel and the members of their families. One often has to hear sharp criticisms on that score, the essence of which can be reduced to the sentence, why worse for us? Any aviation specialist is deserving of respect, of course. But the flight profession, after all, differs from the others in the fact that the warriors of the air, going up into the skies, are under especially dangerous conditions. That is why the pilot is deserving of much more than he has today. The pilots moreover make up just a few percent of the overall flight personnel of the Air Forces, and it would be unfair not to provide them all with everything necessary first and and foremost.

The flight profession, on the other hand, has a specific spiritual and psychological nature as well. Flight safety depends on dozens of factors, including the state of the

soul and the psychological mindset of the pilot. This dependence has always been noted in our aviation. The problem of accidents, however, is frequently considered on a narrow professional plane apart from real life. Read some of the materials from commissions that have investigated the causes for flight accidents three to five years ago, and you will find an abundance of stereotyped accusations of the type, "due to lack of pilot proficiency...," "due to lack of discipline...," "a consequence of violations of requirements of guiding documents" etc. And not a word about the person himself, about the psychological state of the pilot, about the conditions under which he and his family lived. We have as yet been unable to change the state of affairs in accidents owing to an underestimation of the human factor. Today the high command of the Air Forces has placed before itself the aim of solving the problem of safety in flight work in comprehensive fashion—both the professional and the social aspects.

[Correspondent] By the way, the president of the country, after meeting with servicemen who are deputies, has apparently thought some about the social problems in the army as well. A number of decrees have come from him pertaining to the armed forces. But these are all just words so far—what about concrete deeds? Will any appreciable help be coming from the center, from the government?

[Deynekin] I was recently working among the troops stationed in the Baltics, and I met with various categories of servicemen and saw that they still have no concrete material assistance. The prices for goods have meanwhile increased several times over, the housing space for the servicemen has been declared official and the local authorities are demanding payment for teaching children in the schools, have raised the cost of trips on public transport etc. But you will agree that even oral support for the military on the part of not only the president, but also some well-known deputies of the USSR who did not want to hear about raising the social protections for the military people at the start of their service as deputies, during the ideological and economic attacks by nationalistic and antisocialist forces on the army of course gives us the right to hope that the difficulties will be surmounted anyway.

Malicious attacks on the army by forces known to us, however, including through the mass media, have done their work nonetheless. Matters have reached a point where ordinary Soviet women have had to protect the army at the Russian and All-Union USSR Congresses of People's Deputies. We bow deeply to them for that. As for the philistines, their attitude toward the army has become negative.

We should acknowledge at the same time that we ourselves sometimes provide grounds for just criticism of the armed forces. Instances of the death of people during peacetime due to violations of rudimentary safety measures, the more so as a consequence of physical desecrations against fellow servicemen, are especially shameful. References to the fact that the notorious "hazing" comes to us from the civilian environment, that violence is engendered back in the schools, PTUs [vocational and technical schools] and technical institutes, do not seem very convincing to me personally. I am convinced that these negative phenomena take place only in those units where the commanders and political officers are not occupied with the people, do not devote attention to their indoctrination, are not interested in their needs and aspirations.

[Correspondent] When the discussion touches on social problems in the army today, the question immediately arises of where to get the money. What do you think, does the opportunity now exist to redistribute the funds allocated for defense among the military-industrial complex and the armed forces in favor of the protectors of the Fatherland themselves? What is the mechanism for that redistribution, and who should act as the arbitrator?

[Deynekin] Attempts to redistribute funds in the interests of the military fliers are not yet meeting with any success. By way of example, even in a case where industry fails to meet the plan to supply hardware to us, we are not given the opportunity of using the money left over from series production for, say, scientific and technical or experimental-design work, without which we will inevitably lag behind other armies. Funds from that line item cannot be expended for social and cultural needs either.

It would seem to be worthwhile for us to order just one fewer strategic aircraft and build ten or more residential buildings with the funds saved. But everything today is so centralized that there are still no opportunities to realize many intelligent ideas. Common sense and initiative remain, even today, in the tight grasp of the stagnant administrative system.

This is nonetheless no grounds for inaction. Possible variations for concluding contracts with Soviet and foreign firms and companies, the aim of which is to earn additional funds to meet the social needs of the fliers, are being actively studied at the high command today.

I have noticed that AVIATSIYA I KOSMONAVTIKA is pursuing more and more persistently the idea that commanders cannot get by without economic knowledge today. I wholly support that point of view. We must all learn not simply to count money, but how to invest it intelligently in things so that it works in favor of combat readiness and flight safety, for the fighting mindset of the fliers.

[Correspondent] A final question. The withdrawal of our troops from the countries of Eastern Europe will be continuing. The fast pace of this process, divorced from the economic realities of the present day, is aggravating the difficulties still further. We have here, as they say, a colorful mosaic of facts, but what is the overall reality?

[Deynekin] The overall reality is undoubtedly complicated. But I see no reason to succumb to pessimism. If we

were to look at ourselves from the side, we would see that the tempestuous life, full of contradictions, has now largely made us different. We are rejecting the psychology of dependence, we are becoming emancipated in thought and deed, we are getting rid of dogmas and stereotypes, starting with the organization of the combat-training process and ending with the solution of economic problems. We are, in short, restructuring. The main thing at this stage is not to alter our endurance and good sense.

Taking advantage of the opportunity, I want to offer my heartfelt congratulations to all fliers on the Soviet Army Day holiday. I wish them and their families happiness, health and success always and in everything!

Conservative Attitude Toward Advanced Flying Skills Bemoaned

91UM0807B Moscow AVIATSIYA I KOSMONAVTIKA in Russian No 2, Feb 91 (signed to press 13 Feb 91) pp 4-5

[Article by Hero of the Soviet Union V. Menitskiy, chief test pilot of the OKB [Experimental Design Bureau] imeni A.I. Mikoyan and honored test pilot of the USSR, under the rubric "For High Combat Readiness": "In the Background. Why?"]

[Text] *The attitude toward the aircraft-handling skills of the flight personnel, despite the outfitting of line units with highly maneuverable fourth-generation aircraft, continues to be guarded. And that is because days past, when this type of flight training was considered to be secondary and dangerous, continue to have an effect.*

The question of flying skills is a topical one today as well, especially among the pilots of fighter aviation, from the point of view of both flight safety and professional proficiency. I would like to share some considerations based on experience I have acquired in this regard.

I feel that the most important aspect of the conversion of the Air Forces to qualitative parameters is the high professionalism of each flier. The closer the contact between the person and the hardware, the higher the requirements should be for his proficiency. But it is no secret to anyone that the contemporary aviation system, and especially the pilot, costs the state a very great deal, and our people should thus be confident that the hardware is in sure hands. The ability to operate an aircraft properly in all modes consequently comprises the foundation of the professional training of the pilot. I agree entirely with those specialists that flying shills must be taught starting in the cadet years, when the first perceptions of the young flier are the most strong and profound, and the skills must be run through more quickly and mastered more solidly and steadily.

Modern close-quarters aerial combat presupposes maneuvering at maximum G-forces and angles of attack across the whole spectrum of velocities and altitudes. The converse is obtained if we turn to the statistics of the time of the Great Patriotic War—the percentage of aircraft shot down by the enemy from advanced aerobatic maneuvers was significantly lower than in simple maneuvers. If one also takes into account the high performance parameters of contemporary aiming systems and on-board weaponry—making it possible to execute an attack at virtually any aspect angle from long ranges—grounds appear to suppose that the mission of destroying the enemy can be performed in long-range missile battle, and that it is enough just to master target search using on-board radar.

Here, it seems to me, lie the roots of the confusion. First of all, the pilots of front-line times, shooting down aircraft from simple positions, escaped enemy fire only with the aid of maneuver at flight parameters close to the limits. Second, one can discern, with attentive study of contemporary missile battle, the obligatory presence (if the mission is worth victory) of elements of advanced aerobatic maneuvering and the utilization of the utmost capabilities of the aircraft.

Airborne interception, as is well known, starts with detection. In order to be the first to "lock on" to the "enemy," approach him covertly or break off his detection, it is necessary, depending on the capabilities of the on-board radar, to know how to maneuver at the lowest possible altitudes, at the highest and lowest possible speeds, and to alter direction and velocity sharply, which entail large pitch and attack angles and G-forces. Flight at minimal speeds and large angles of attack in and of themselves require great skill in controlling the aircraft.

A win in a one-on-one situation after the simultaneous launch of missiles is ensured by energetic maneuvering at the edge of the permissible. The maximum G-forces can be quite prolonged therein. One cannot get by here without physical tempering. That is achieved only through purposeful physical training and regular flights for aerobatic maneuvering.

Today we face maneuvering over the surface of the water or terrain without points of reference under difficult weather conditions or at night. Only a pilot with solid skills in aerobatic maneuvering can preserve his spatial orientation and monitor clearly his actions in such maneuvers. The aiming system makes it possible to aim in virtually any maneuver without plotting altitude, roll or G-forces. The pilots of highly maneuverable aircraft should thus be able to execute complex maneuvers by instrument, which is very difficult to do without good aircraft-handling training under simple conditions.

There have been occasions in flight practice when pilots occupied in working with the sight got into a difficult situation and could not then assess it correctly. Their aircraft-handling proficiency was unfortunately poor, while the ban on aerobatic maneuver that existed at the time had degraded their already shaky skills. And people cannot be blamed for it, since the preconditions for such

situations were inherent in the training system itself. But one need not be a scientist or psychologist to understand that even the most solid and stable skills are destroyed without practice. Practice testifies to the fact that in flights for combat maneuvering under difficult conditions, over the ocean or at night, only excellent training proficiency in aerobatic maneuvering makes it possible to preserve clearly the assigned parameters for movement and overall orientation in space.

The most important role in aiming at victory is relegated to tactics. The aerial warrior should be constantly improving his tactical devices in this regard. Their study and practice by the flight personnel are unfortunately sometimes not distinguished by diversity, even though a by-the-numbers and trite approach has never provided good results in battle. The commanders know this, but it is difficult for them to reject their accustomed systems. The experience of World War II and subsequent local wars teaches that maneuvering and tactical devices are often born right in battle, the fruits of improvisation, as it were. And improvisation is the consequence of a creative approach to the solution of the problem, the foundation of which comprises profound knowledge of the field and high professionalism.

I became convinced, while showing pilots aircraft performance in maximum flight modes, that if a person is constantly improving his flying skills, he will adapt quickly to a situation that is new to him. Knowledge of realms of flight previously unknown provides an impetus for creativity, and many pilots have proposed tactical maneuvers on the basis of specific features they have mastered in the performance of the aircraft, even such negative ones as stalling. During wartime, by the way, it was sometimes employed in dogfights and led to enemy confusion.

It must be said that interest of the flight personnel is very high in substantiating the behavior of the aircraft at maximum modes connected with maneuvering. The host of questions and suggestions offered makes obvious the mutual connection among the knowledge, experience and moral and psychological training of the pilot, which is linked with confidence in his powers and directly reflected in his skills and in flight safety.

One must hear frequently that this or that record-holder performed poorly in domestic competitions. About which the trainers usually say that he was burned out, that he was not psychologically prepared even though his functional capabilities were high. An ability to control oneself is very important for pilots, since that is connected with the fulfillment of crucial assignments and the preservation of one's own life. Lofty moral and psychological qualities do not come by themselves—they are the product of indoctrination, solid professional knowledge and abilities. High piloting skills across the whole spectrum, including extreme modes and aerial combat, help the pilot to orient himself in the dynamic of flight and react instantly to the situation, while undoubtedly increasing his readiness for actions in special cases. Difficult types of flights inspire the pilot and raise his psychological tenor. You have to see how the eyes of a person shine after aerobatic maneuvers. Confidence is felt immediately—he will handle any special situation, because he knows how to act. I remember a case where the testers were directing the attention of pilots in the line units toward the possibility of making full use of the longitudinal control channel at severe angles of attack in a critical situation. Two crews that were flying close to the ground later got into a seemingly hopeless situation, but employed this maneuver and completed the flight safely. Such moments can be frequent in a combat situation. The feeling of confidence, solid skills and knowledge, self-possession and a clear head thus make it possible to improvise boldly in aerial combat.

Professionalism and flight safety are links in the same chain. Accidents can be avoided for a certain time, of course, through the method of prohibitions, but that is a transparent safety. Our fliers have tasted the bitter fruits of the prohibition madness more than once. Even today one sometimes has to prove such obvious truths. The assimilation of aerobatic-maneuvering skills is undoubtedly a difficult and thorny path. It is, however, the only one toward the pinnacle of professional mastery and psychological firmness of the aerial warrior and, that signifies, to flight safety as well.

Unfortunately, not all commanders bearing direct responsibility for the state of affairs in the units share this point of view. Captives of old concepts and instructions, covering up with slogans about raising proficiency ratings and safety, they push aircraft-handling training into the background. Everything looks outwardly fine—there are many pilots with proficiency ratings, excellent subunits and high scores when summing up the year's results.

All of this outward luster, however, cannot conceal the potential bearers of the precursors of flight accidents, the principal cause of which is poor aircraft-handling proficiency. Proficiency ratings should never be an interference to it. The level of piloting skills, on the contrary, should be judged according to them. Then the commanders will be forced to put it at the head of aerial proficiency, especially of young fliers, who must solidify their flight skills more quickly.

I am completely convinced that if the teaching of aircraft-handling skills were to occupy its proper place in the system of combat training, then growth in the skills of pilots in weapons delivery, precision formation flying and instrument flying would be assured. The experience of the leading fliers—the best aircraft handlers and masters of weapons delivery—is evidence of that.

Reasons for Lack of Flight Initiative, Risk-Taking Viewed

91UM0807C Moscow AVIATSIYA I KOSMONAVTIKA in Russian No 2, Feb 91 (signed to press 13 Feb 91) pp 6-7

[Article by Combat Pilot 1st Class Lieutenant-Colonel Yu. Andronov under the rubric "For High Combat Readiness": "Within the Limits of the Allowable"]

[Text] *Judging from the letters that come to the editors, fliers have not remained indifferent to the discussion that has been started on improving the combat, morale and psychological qualities of aerial warriors. It has thus been decided to continue the exchange of opinions on this topical issue.*

It must be owned that not so long ago we judged the ways of developing combat qualities with excessive simplicity and unjustified optimism. We spoke what it was more convenient to say rather than what we felt for too long. I think that the inertia in our thinking, the ingrained nature of old habits and an inability competently to teach pilots how to wage combat operations within the established safety limits, all had an effect here.

So you have commanders urging on the plan for the training of first-class pilots without thinking about how they will conduct themselves in an encounter with a real enemy in the air; will they be able to perform the combat mission despite the mortal danger? And what about the appeals to "raise combat readiness," "display initiative in the air" and "act decisively"? The appeals remain appeals! While in real life the pilots fear to take responsibility for decisions made, because the fear of inevitable punishment dangles over them (according to the experience of other pilots) for a possible mistake.

The question of preparing for battle sounds simply rhetorical at first glance. But is is no accident that it has been asked, since I once had occasion to witness a curious dispute on this score, on which the opinions of the fliers differed.

* * *

The lead pair of Combat Pilot 1st Class Major F. received, during bilateral exercises, the mission of not permitting the aircraft of the opposing side access to targets and blocking their actions.

All of the pilots' thoughts were focused on one thing—finding the "enemy" and attacking him as fast as possible. But active jamming, as it later turned out, was being employed, which made vectoring the fighters from the command post much more difficult. The lead pair then received the command to switch to independent search. This had not been such an easy chore without prompting from the ground, but it became even more difficult for the pilots when they detected a target in quite a different place from where they expected it. Now they had to force a fight immediately, performing a series of energetic and complex maneuvers, in order to gain position for attack. But... the intercept with the "enemy" never took place. The lead later explained his refusal of one-on-one combat by the fact that he and his wingman had not yet recovered their skills in waging aerial battle with fighters since their leave. Was the experienced pilot correct in this situation?

Certain pilots, and they are in the majority, would assert that he was correct. Because he did not violate that holy of holies—the rules of flight service, did not rely a little on his many years of experience and even presented his wingman with a lesson in reasonableness. Others condemn his decision, emphasizing that no breaks in flights should be an impediment to the achievement of victory in such situations, even if it is just a training battle. This playing-it-safe by the lead man, they say, allowed the "enemy" to reached the assigned target and attack it with impunity.

It would seem to be difficult not to agree. But one question here gives me no peace: what were the commanders counting on, knowing the lack of preparedness of Major F.'s pair and even giving the "OK" for their sortie? One can only guess. And it is not difficult to guess what the lead man was thinking about in the brief instant of the attack, facing the choice of risk or reasonable caution at this juncture. Count on the off-chance that the senior divisional officers of the tactical air exercises will not check up on the level of training, and then—excellent! And if so, then the inevitable and deserved punishment: rules are rules.

And this was confirmed once more by the incident that happened with Major Derevyanko that was related in the article "Testing by Initiative" (AVIATSIYA I KOSMONAVTIKA, 1990, No. 12). The pilot suffered entirely just punishment for "violation of the commander's instructions." But have we thought about what these instructions came down to? Strange as it may be, it was namely the commander who, through his own willful decision, determined the angle of dive at 20° in the launch of the guided missile, thereby depriving an experienced pilot of the possibility of choosing a more acceptable method of delivering his ordnance.

A question suggests itself herein: for just whom is the Course of Combat Training, offering broad opportunities for increasing professionalism, written? Is it really for those commanders who see in every flight performed a cherished check-off on the flight-training plan, and not the next step toward the heights of flight mastery?

I can already hear the objections of those who feel that if you let the pilots go, how many will they crash trying to get a reputation as a brave aerial warrior? But that is where the commander's bent should be displayed, to investigate such motives among subordinates correctly and ascertain their basis—either it is strong knowledge, solid skills and high tactical mastery, or it is a manifestation of conceit mixed with vanity, or even simply foolhardiness.

But I am permitting myself even the idea that pilots will be found who have not felt at some time in the sky a feeling of combat fervor, the desire to "outplay" a cunning "enemy" employing tactical tricks. Such fervor as evidently possessed Lieutenant A., when he accurately hit the ground target after having performed energetic maneuvers over the test range. How one wanted to be carried away by his actions. One thing, however, kept many from it—in the heat of the attack the pilot, seized by just the single idea of attaining an excellent result in weapons delivery, fired from a range less than that permitted by the assignment, and exceeded the assigned G-forces when pulling out of the dive in order to avert flying through the ordnance shrapnel.

A. later tried to justify himself by the fact that a true fighter-bomber pilot, he said, is one who bombs and strafes without a miss, who inflicts a defeat through firepower on the enemy in the very first attack. All right then, difficult to argue. But how often there are direct recklessness and a negligent attitude toward the rules of flight service, written in blood, behind such bravado!

And who is right, anyway? A first-class pilot who does not violate any prohibition but lets victory slip away, or one who knowingly crosses the boundary of flight safety for the sake of fulfilling the mission assigned to him?

Someone, I am sure, will refer in seeking an answer to the large number of published documents that supposedly restrain the professional growth of the pilot, to the conditions under which he unwillingly remains just the conscientious performer of paper requirements and instructions that say "not permitted..."

But however broad the expanse of the skies may be, it has become crowded there now as well, and one cannot in any way avoid certain restrictions dictated by the strict rules of safety. Another question is how a pilot can find the path to the manifestation of his his best warrior qualities under such conditions. Can this contradiction be tolerated?

It seems that there are possibilities for this. They are quite broad for those who see the way to victory in the skillful combination of flight mastery and the merits of the aircraft, who live by a burning desire to act in an everyday situations as in a real battle! And only those who are inclined to treat the concept of "initiative in battle" as boundless freedom in their actions in the air are squeezed into the narrow framework of what is permitted.

Three-time Hero of the Soviet Union Marshal Aviation I. Kozhedub once noted, in a conversation with young pilots, that bravery without tempering is the same thing as a firing a blank. Enthusiasm alone, the desire to be a hero alone, is not much. It is enough for just a brief skirmish, but not for long and stubborn battle. Because battle is labor, and skill is important in labor. This statement by the honored ace confirms once again the truth that one cannot take a risk on bravery alone, if it is not backed up by profound knowledge of the hardware and tactics, an ability to handle weaponry in masterly fashion and an accounting for the specific features of modern battle.

Experience, of course, comes only with the years for most pilots. But it is nonetheless always gladdening to see how young pilots become true aerial warriors in a comparatively short period of time, ceding nothing in skills to the "elders." How do they achieve such successes?

I observed, for example, the following episode at recent exercises. A flight of fighter-bombers led by Senior Lieutenant V. Ivanov was to suppress a battery of "enemy" SAMs that had been detected in the course of battle. The developing situation, however, required that the regimental commander redirect the pilots to a new target—the reserves of the opposing side that had moved up to the staging area. The young pilots hit them, displaying tactical wit and enviable skill, and performed the mission assigned earlier in a second attack. When I asked Ivanov how he had been able to guess at a possible change in the tactical situation in the air and depart the the aerial situation as the victor, he showed me his notes, made when preparing for the upcoming tactical air exercises. And I saw a carefully developed model, confirmed by the results, of possible variations in the delivery of strikes against targets of the hypothetical enemy. One of them, the best suited to the conditions prevailing in the battle, had indeed been used by the pilots of the flight.

Military cunning always entails some risk, and he who knows how to take it in well-founded fashion gains an appreciable tactical supremacy over his enemy. Risk, of course, is by its very nature unsafe. And whereas the necessity of it is obvious in a combat situation where a real enemy is operating, it is exceedingly difficult to define its permissible boundaries in training flights, where the enemy is still hypothetical. This is a very subtle matter. A mechanism that would permit the dispassionate determination of the line across which the pilot has engendered an antagonism between reasonable risk and the rules of flight safety has not been and will not be developed thereby.

Much wisdom must be assimilated so as to attain the heights of combat mastery. But it must always be remembered that risk cannot be based on extemporization, even though one sometimes cannot get by without it. True, within the limits of the permissible. But how do you feel?

Reliability of Flight Personnel Linked to Safety

91UM0807D Moscow AVIATSIYA I KOSMONAVTIKA in Russian No 2, Feb 91 (signed to press 13 Feb 91) pp 10-11

[Article by USSR APN [Academy of Pedagogical Sciences] Academician Major General of the Medical Service V. Ponomarenko under the rubric "Combat

Training and Flight Safety: A Scholar's Opinion": "The Professional Reliability of Flight Crews"; conclusion of article from No. 1]

[Text] The short-sighted attitude of society toward the labor discipline of people in hazardous professions, along with the drop in prestige of service in aviation, is a socio-psychological condition facilitating a decline in the reliability of the human factor. The requirement to enroll individuals from indigenous nationalities in the flight schools regardless of their abilities is a typical example. This has led to the fact that only 42.5 percent of them complete the full training cycle, while the percentage of dropouts among those who have completed sport-aviation clubs is about five.

The causal links between the traits of the individual and professional reliability—that is, between the degree of markedness of the typical features of a person and his erroneous actions—have been firmly established today. The unfavorable qualities characteristic of individuals below the second groups of the selection process have the highest positive correlation factor.

The reliability of the actions of specialists in hazardous professions depends largely on their morale, and is closely linked with the social security for the rear areas—family, the future and services, among others—as well as the motivation for labor. A negative attitude toward work has been established as the result of research among 19 percent of the crews of army aviation, 16 percent for frontal aviation and 18 percent for long-range aviation. The principal causes for a decline in motivation are the difficult situation in the garrisons as regards schools and pre-school institutions, a lack of confidence in basic life amenities after discharge and poor conditions for individual improvement of professional skills.

The wives of the pilots have a substantial influence on the appearance of a negative mindset. Here are some data. Among those polled at certain garrisons (more than 600 families), only three percent of the husbands regret their choice of profession, while for the wives it is 69. Some 11 percent of the officers and 20 percent of their spouses do not like their place of service, while those not satisfied with family relations (due to unemployment or tiredness) are 27 and 50 percent respectively.

The fliers are engaged in service for 332 hours a month, while it is only 176 for those serving in state institutions. Twenty percent of the families of pilots have income per family member of 65 rubles, with 47 percent at 125 rubles and 29 percent at 250. Only 25 percent of the flight personnel correspond in calendar and biological age, while 46 percent have a biological age exceeding their calendar age, that is, the accelerated aging of the body is evident, against a background of an unsettled workday, strained social, domestic and emotional situations and the drop in prestige of the profession. These data point out the potential unreliability of the human factor when higher physical and psychological burdens are placed on the body and the personality. The experience of the war in Afghanistan visibly confirms this idea: more than 40 percent of the fliers were taken off flight work owing to illnesses after their return to the Motherland.

All of the aforementioned insistently demands the realization of the postulates of the minister of defense—that the person is at the center of concern. This should be transformed into the humanization of labor and the vital activity of the flier for all who support the reliability of crew actions. This is understood to mean the creation of such conditions under which he (namely thanks to the human factor, and not in spite of it) achieves the best results in work, preserves his health and experiences moral satisfaction from the awareness of its necessity and utility.

I imagine the following stages, in the near future, for solving the problem of raising the role of the human factor in ensuring accident-free flight operations.

1. The psycho-social revival of the vital activity of the aviation collectives in the course of military reform at the level of state policy.

This stage presupposes: trustworthy information on the actual working conditions of fliers; legal norms for social protection in the event of the loss of motivation for flight work due to loss of occupational health or due to the absence of proper conditions for service and everyday life; a focus on the principle of the "presumption of innocence" in investigating the causes of accidents, taking into account the whole set of circumstances, including the personal responsibility of the pilot; the creation of a new medical direction for preserving occupational health on the basis of restorative centers and expert computer interactive systems, allowing the pilot to perform self-monitoring of the correspondence of his state of health to the specific burdens and of the dynamic of psychological qualities of professional importance; self-assessment of the level of readiness for flights; the creation of a higher psychological-pedagogical school to train instructors in flight training; and, the institution of new instructional approaches to the indoctrination of the pilot's personality based on a replacement of the principle of "distrust through monitoring and reporting" to "trust through self-monitoring and self-reporting."

2. A technological breakthrough in the realm of the pedagogical process through the realization of new principles for structuring the technical means of instruction.

The principal directions: the creation of simulators imitating the effects of the psycho-physical interference characteristic of flight work (the effects of acceleration and gravity on the vestibular apparatus, fluctuations in brightness and noise, the efforts of control organs and shifts in the axes of coordinates in spatial orientation, among others), for a customized approach to the stages of flights and various types of weapons delivery; the development of functional simulators, using hybrid computer technology, for the adaptive training of operative

thinking when resolving problem situations, making it possible to automate the extraction of evaluations according to the dynamic of the formation of skills and their disintegration, and strictly regulate the level of complexity of the issue of material being assimilated depending on the individual abilities of the student.

Training using those technical means should be by levels. The mental qualities and individual traits of the personality that determine success in the assimilation of flight work (generalization, abstract thinking, ability to judge by eye, a feeling of exertion, time and spatial representations, among others) are formed at the first level with the aid of personal computers and other apparatus. The second uses modular simulators that form skills in certain basic actions (navigation, aircraft handling, reconnaissance, aerial combat), including against a background of psychological interference. The third employs an integrated simulator to practice professionalism with a regard to the performance of tasks of varying complexity and the automated evaluation of the level of readiness for the fulfillment of flight assignments.

3. Design engineering of the man-machine system based on the principle of raising human capabilities.

Included among others developed at the Institute of Aviation Medicine are computer expert interactive systems that make it possible to issue nominal data for the potential unreliability of the person, depending on the working conditions, as early as the stage of design engineering of the hardware. These data, with a regard for the dominant harmful factor and the capabilities of the body, make it possible to optimize solutions when selecting means of protecting the person and issuing recommendations for the prevention of occupational illnesses in timely fashion. The automated system to avert losses of consciousness by the pilot and improving the perception of flight information under the effects of large G-forces could also be relegated here.

The adoption of these technical solutions in the interests of flight activity are nothing more than a replacement of the machine-centered principle with the anthropocentric one, that is, a transition to general human values. If those of us engaged in the formation of the aviation social system are able to restructure our thinking and activity in these directions, one may hope for a positive resolution of the dramatic collisions in the service and personal life of the fliers that were discussed in the article along with a rise in the combat readiness of Air Forces units to a new level.

Captain Discusses Reasons for Quitting Party

91UM0807E Moscow AVIATSIYA I KOSMONAVTIKA in Russian No 2, Feb 91 (signed to press 13 Feb 91) p 19

[Interview with Combat Pilot 1st Class Captain Sergey Bukanov by AVIATSIYA I KOSMONAVTIKA special correspondent Captain V. Cherepkovskiy under the rubric "Party Life: Candid Talk on an Important Subject": "I Remain a Communist, but... in my Soul"]

[Text] *Despite the efforts of party organizations in the aviation units and subunits to preserve unity and cohesion in their ranks, the departure of communists from the CPSU is continuing. What impels people who often have a solid party record to make such a decision? Former CPSU member and Combat Pilot 1st Class Captain S. Bukanov answers these and other questions from our special correspondent Captain V. Cherepkovskiy.*

[V. Cherepkovskiy] Sergey, first the obvious question. Why did you leave the party?

[S. Bukanov] It was not an easy decision, to tell you the truth. I had to think hard. As for the reasons...

It so happened that I was on leave during the work of the 28th Congress. I had a rare opportunity for a line pilot to see everything that transpired at the sessions on television and to read the newspaper reports and commentary. And the more deeply I looked into the materials from the congress, the more strongly I felt resentment and dissatisfaction. Like they were deceiving me with good intentions.

[V. Cherepkovskiy] What do you have in mind?

[S. Bukanov] They spoke a great deal and coherently at the congress about the state of society, the prospects for development and the renewal and democratization of the party. On ways of ensuring the safety of the country and reinforcing the army. But my personal conviction was that the congress did not go beyond general phrases. Take the resolution, "Basic Guidelines for Contemporary Party Military Policy." One need not be a major policymaker or military strategist to understand that this was a "raw" document. You read it and nothing remains in your head except "the congress declares, must be investigated, improve work" etc.

[V. Cherepkovskiy] But that is still not an answer to the first question...

[S. Bukanov] Fine, we'll go back to it. I'll tell you like it is: I left the party consciously. No one was "working" on me, "pressuring" me. I will not join any parties, fronts or informal organizations. And if we are talking about the reasons that accelerated my decision, one of the principal ones is the discrepancy of the words and actions of our party figures. What's more, their opinions often changed to completely opposite ones over the course of a few days. Can that really be permissible? To whom can the rank-and-file communists equate themselves, from whom can they learn steadfastness and fighting qualities?

[V. Cherepkovskiy] But, honestly, perhaps your action was associated with irritation at the party organization and the command?

[S. Bukanov] There's no irritation or protest here at all. Although, turning to the past, one could find many formal reasons.

Say the issue of the selection of candidates for promotion was being resolved in the squadron. I was among them. But, conferring with the party activists, the elders in the command concluded—he is too young, let him work a little, gain some experience.

A new opening opens up a few years later. They tell me—you're a little old, it doesn't fit. Is that fair? Who will explain why I grew right up to an elder pilot over twelve years?

It is irritating. But not enough to lay my party card on the table. The picture is the same in other units and subunits too, after all: experienced pilots are not noticed for some reason, and they frequently remain "overboard." I feel it is long past time to look into that problem.

[V. Cherepkovskiy] Tell me, what was the attitude of the communists in the squadron to your declaration?

[S. Bukanov] It varied. The secretary of the party buro tried to convince me not to rush into a final decision. As for my comrades... Some approved it and others condemned it, although I felt in my heart that they supported me. It is simply not accepted here to express one's opinion frankly and honestly yet. The principle of "whatever happens, happens" is alive and well.

[V. Cherepkovskiy] So then, there are that few bold and principled people in the squadron?

[S. Bukanov] Looks like it. I give you a hundred-percent guarantee that many communists would have left the party already today for various reasons. They talk about it openly at the airfield and in the break room. But everything seems fine at the party meetings. So criticism is not even heard, especially directed toward the leaders. Criticism, after all, is a stick whose other end could hit you as well... I feel that if a communist sees shortcomings, unfairness and arbitrariness among superiors and remains silent, then the party card isn't worth a plugged nickel.

You don't have to go far from an example. When I left the CPSU, an expectant silence descended on the regiment at once. Everyone wondered how the command and political bodies would react.

[V. Cherepkovskiy] They were waiting for practical conclusions?

[S. Bukanov] I was not ruling out extreme measures either. A rumor immediately began circulating around the collective, after all, that Bukanov would be taught a lesson for such actions. And what's the most terrible thing for a pilot? Depriving him of the opportunity of flying, of course. That, fortunately, has not happened yet.

[V. Cherepkovskiy] I am getting the impression that you are a confirmed advocate of the departization of the army.

[S. Bukanov] I vote "yes" with both hands. And here's why. It is well known that military service and mutual relations in the military collectives are structured on sole responsibility. There are, however, actually three "commanders" in the same squadron—the squadron commander, the deputy for political affairs and the secretary of the party buro. Each demands his due. If the combat news sheet is not out on time, you risk falling into the bad graces of the political officer. If you refused to speak up at a party meeting on a pre-arranged topic or said "that's not so," you are now on the hook with the party boss.

Or take the prevailing system of assignments and movements of officers. How can it be understood when the party organization, if you consult with it, refuses the candidacy of this or that communist only because he is supposedly insufficiently active in social life and rarely speaks up at meetings?

And what if a person is modest by nature and doesn't like to prattle on? And what if the pilot is "descended from heaven" therein or is highly talented? The "red light" is in store for him his whole life? That is wrong, that is unfair. You unwillingly get the idea, do we really need such party organizations?

[V. Cherepkovskiy] But most communists, after all, are still in favor of preserving them provided there is a division of functions with the military political bodies and the command...

[S. Bukanov] I am not pushing my point of view on anyone. But I am convinced that the party will be completely removed from the army in the near future. And that will work in favor of the combat readiness of the units and the fliers' fulfillment of their chief mission—the reliable defense of the aerial boundaries of the Motherland.

[V. Cherepkovskiy] I would like to know what the plans of non-party pilot Bukanov are.

[S. Bukanov] I will serve as before—honestly, conscientiously. And I want to say something else. One can feel oneself a communist without keeping to the name. One can, at the same time, be outside the ranks of the CPSU and be several orders higher than many party members in all respects. You don't carry communist convictions around in your pocket with your party card. I remain a communist as before. But... in my soul. And I will try to prove that in my service, practical affairs and life stance.

Flight Records of Su-27 Reviewed

91UM0807F Moscow AVIATSIYA I KOSMONAVTIKA in Russian No 2, Feb 91 (signed to press 13 Feb 91) pp 22-23

[Article by engineer G. Grishayeva under the rubric "Soviet Aviation Hardware": "27 Records for the Su-27"]

[Text] *We talked about this fourth-generation fighter in the article "The Su-27: Vertical Takeoff" (AVIATSIYA I KOSMONAVTIKA, 1989, No. 9). Now we offer readers some new information on the specifications and performance characteristics of the aircraft and the world records it has set.*

The design engineering of the interceptor, which had received the working designation T-10, was begun under the guidance of P. Sukhoy in 1969. V. Ilyushin, the chief pilot of the OKB [Experimental Design Bureau] imeni P.O. Sukhoy, took the aircraft aloft for the first time on 10 May 77. They were able to achieve such characteristics in the process of subsequent refinement that it was able to become the celebrated Su-27, whose handling qualities are now praised around the world.

A series-produced craft took off on 20 Apr 81. The outfitting of line units with contemporary fighters had begun. The Su-27 won universal recognition from pilots.

"...The idea of entering the battle to hold world records in its aircraft class was born in 1986. We already felt and understood that the craft was capable of a great deal. We were so confident of it that we did not even build a special one, but just took a series-produced one, and moreover one that had already served well aloft. The aircraft, of course, had to be prepared in accordance with the rules of the FAI [Fédération Aéronautique Internationale]. It was designated the P-42 in memory of the Soviet soldiers who had achieved the great turnaround in the Battle of Stalingrad in November of 1942. At that time our aviation, in defending the Volga stronghold, played a large role in the rout of the enemy," recalls M. Simonov, the general designer of the OKB imeni P.O. Sukhoy.

Any flight requires preparation, and especially when breaking records. It was conducted under exceedingly rigid conditions, and the pilot was to know all of the nuances of the craft's behavior and possess skill, deliberation and composure. He had to be on the alert at takeoff, in climbing and on the heading so as to maintain the flight profile. There are also no few specific features in landing, since the runway must be touched at a certain speed at the point at which the measuring apparatus is pointed. This is especially important when setting records in class N—a short takeoff and landing aircraft—in which modern high-speed craft had not appeared before the Su-27. The length of the takeoff or landing runs in this class cannot exceed 500 meters.

Many clever ideas had to be thought up and employed by the ground specialists to restrain the aircraft at the start when operating the engines in afterburner mode, as well as for the precise recording of the parameters of its movement.

An enormous tracked vehicle firmly attached to the runway was employed as a restraining device, with an electronic lock that allowed precise determination of the time to let go. A transceiver for operation with the ground radar station had to be installed for the automatic training of the cine-theodolite. An increase in the recording frequency made it possible to triple the precision of altitude measurements. The control of thrust equilibrium from both engines was no less important, since an imbalance could "carry" the aircraft off the assigned trajectory. Much attention was devoted to computing the refueling, since each kilogram of mass of the aircraft has an effect on the characteristics being determined, especially the rate of climb.

Recall that the records attained by American pilots using the F-15 tactical fighter on 16 Jan 75 appeared in the table of world records at that time: R. Smith had reached an altitude of 3,000 meters in 27.5 seconds, and P. McFarlane had reached 6,000, 9,000 and 12,000 meters in 39.33, 48.86 and 59.88 seconds respectively.

Then OKB test pilot V. Pugachev entered the table of world records at once with eight records for rate of climb on 27 Oct and 15 Nov 86: four in the ground-based aircraft class and in the subclass of medium aircraft (takeoff mass under 16 tons), gaining an altitude of 3,000 meters in 25.373 seconds and 6,000 meters in 37.05 seconds. His comrade N. Sadovnikov went up to 9,000 meters in 44 seconds, 12,000 meters in 55.2 seconds and 15,000 meters in 70.329 seconds on 10 Mar and 23 Mar 88. He also was the first to attain a record in class N for altitude of horizontal flight, at 19,335 meters, on 10 Jun 87. The last world-record achievement achieved by the Su-27 up to the present day was 15,000 meters in 81.71 seconds with a load of 1,000 kilograms by V. Pugachev. Some 27 world records in all have been set by the test pilots of the OKB imeni P.O. Sukhoy, V. Pugachev, N. Sadovnikov, Ye. Frolov and O. Tsoy.

The Su-27 has other achievements to its credit that have not yet been certified by the FAI. On 28 Apr 89 V. Pugachev was the first in the world to perform dynamic braking reaching an angle of attack of 120-130°—a maneuver that has received the name of the "Pugachev cobra"—for the purpose of determining the possibilities for expanding the performance characteristics of the aircraft. He also performed a "figure-eight scan from takeoff" within the range of 800 meters in altitude, which no fighter had also ever been able to do before, at the Air Show '89 at Le Bourget. OKB test pilots N. Sadovnikov and N. Votintsev, using an Su-27UB refitted with a boom for aerial refueling, flew on the route Moscow—Komsomolsk-na-Amure—Moscow with four air-to-air-missiles without landing, covering a distance of 13,440 kilometers in 15 hours 42 minutes.

Many of the design-engineering solutions found when preparing for the record flights have already been utilized to a considerable extent in practice, and that means that the fighters entering the line units will give the pilots new opportunities for perfecting combat maneuvers.

Characteristics of the Su-27 Aircraft %

Length, meters	21.94
Height, meters	5.93
Wingspan, meters	14.7
Wing area, m^2	62
Wing sweep along leading edge, degrees	42
Width of landing gear, meters	4.34
Wheelbase of landing gear, meters	5.8
Takeoff mass, tons:	
—normal	22
—maximum	30
Quantity of refueling, tons	up to 10
Maximum Mach in flight	2.35
Practical ceiling, meters	up to 18,000
Maximum range, kilometers	up to 4,000
Maximum operational G-forces	9
Takeoff/landing runs, meters	500/600
Number and type of engines	2xDTRD-31F
Total static engine thrust in after-burner mode, tons of force	25
Starting thrust-to-weight ratio	1.1

French Rafale Fighter Described

91UM0807G Moscow AVIATSIYA I KOSMONAVTIKA in Russian No 2, Feb 91 (signed to press 13 Feb 91) pp 36-37

[Article by engineer M. Levin under the rubric "Foreign Aviation Hardware": "The French 'Squall' of the 21st Century"; based on materials in the foreign press]

[Text] The creation of a modern fighter is a complicated task requiring major appropriations, the availability of skilled and experienced developer personnel, efficient SAPR [computer-aided design] and a strong experimental base. The majority of countries around the world are currently not up to the independent creation of new and highly effective combat aircraft, and they resort to international cooperation to a greater or lesser extent. Only three states—the USSR, the United States and France—retain the necessary scientific, technical and economic potential and pursue a policy of independent production of new aircraft.

The aviation traditions of France were laid down back at the beginning of the century, when it was a kind of "aviation Mecca" for all enthusiasts of the newly conceived aircraft building. After World War II the firm of Dassault-Breguet created a number of well-known fighters in the Mirage family, the last of which (the Mirage 2000) began entering service at the end of the 1970s. Aircraft from prior generations also continue to be operated—the Mirage III/5 and Mirage F.1 in the air force, the Super Etendard and Crusader in the navy—that are to be replaced by the end of the century by the Rafale ("Squall") multirole supersonic fighter currently under development.

Preliminary research on the creation of the new combat aircraft from the Dassault-Breguet firm began at the end of the 1970s. The Rafale A experimental fighter—a single-seat, twin-engine aircraft executed in a "canard" configuration with a triangular wing with dual sweep on the leading edge and slab forward horizontal empennage—was built in 1986. Its design made broad use (more than 25 percent by mass) of composite materials, principally carbon plastics, and in general about 35 percent various types of new materials, including aluminum-lithium alloys, as well as titanium subjected to superplastic formation and diffusion welding.

The Rafale has demonstrated sustained flight at low altitude at speeds up to 158 km/hr and angles of attack of up to 32° during flight testing, as well as landings with maximum braking from the moment of touchdown of the main landing gear. Among the values achieved were Mach 2, a top speed of 1,390 km/hr at low altitude, a ceiling of 15,250 meters and G-forces of +9 and -3.6. The aircraft can land with a runout of 300 meters without using a braking chute, and take off in 400 meters in interceptor configuration.

The Rafale D combat aircraft (ground-based) and the Rafale M (ship-based) are being developed as all-weather aircraft, able to strike ground targets while overcoming enemy target AA defenses at low altitude and perform interceptions at various distances from the sortie airfield.

The installation of a digital remote-electronic flight-control system (EDSU) with a three-channel back-up configuration is planned to provide for optimal control of the control surfaces. The EDSU makes it possible to lessen the effects of turbulence at low altitudes, facilitates the suppression of flutter, increases landing precision, decreases the maneuverable loads on the structural elements and provides for flight at large angles of attack.

The Rafale D will have landing gear of conventional design, while the Rafale M will have a "hopping" forward strut to "rear up" the aircraft at the moment of leaving the deck of an aircraft carrier.

The power plant is two SNECMA M. 88-2 twin-shaft ducted-fan turbojet engines with a digital control system. Servicing is simplified thanks to the modular design,

assurance of easy access to the components and positioning of systems under the engine. The repeated calibration of the engines is not required when it is overhauled. A built-in system computes the wear on various parts. The configuration of the "half-under-fuselage" air intakes is an original one: they are located under the lateral leading-edge extensions and combine the advantages of side and under-fuselage air intakes.

The radar set developed for the Rafale has a phased antenna array with electronic scanning and comprising more than 1,000 receiving and transmitting modules. The radar supports the operating modes of "air-to-air," "air-to-sea" and "air-to-ground." It will be able to perform a search for up to eight airborne targets simultaneously in the upper and lower hemispheres, their identification and tracking and support for the salvo launch of four Mica guided missiles. The required range of detection is 110 kilometers when searching by velocity and 93 kilometers when searching by range in the upper hemisphere. The detection range in the lower hemisphere is also 93 kilometers in the forward quadrant and 55 kilometers in all other quadrants. The radar will be able to detect targets with a radar cross section of 0.1 m^2 or more in scan mode in the lower hemisphere. The scanning zone is $\pm 70°$ in quadrant elevation and $\pm 60°$ in azimuth.

In the "air-to-ground" mode, the radar provides the aircraft with the opportunity of performing missions in breaking through enemy air-defense zones under any weather conditions and inflicting strikes on ground targets with the automatic or semi-automatic tracking of the terrain at speeds up to 1,110 km/hr. The "air-to-sea" mode has been optimized for the performance of anti-ship missions, and makes it possible to perform a search and assessment of the significance of targets at long range with their simultaneous tracking and control of high-precision weaponry.

The OSF forward-looking electro-optic system will be installed on the French aircraft for the first time starting in 1999, and it will supplement—or, in some cases, replace—the radar. It is able to detect airborne targets at ranges of 70-80 km and identify them at ranges of up to 24 km, provide for tracking and depiction of range, speed, target angle and elevation with correlation when required and, in combination with radar and EW equipment, warn the pilot of a missile attack. The OSF also supports the navigation of the aircraft when surmounting enemy air defenses. It includes infrared sensors and a laser rangefinder.

The Rafale aircraft will also be able to fly at an altitude of 60 meters. The relatively small radius of action in the high—low—high altitude profile without wing tanks, however, conditions the necessity of its flight in the target area at medium altitudes. Especial attention is devoted to practicing the PECTRA EW system (the gear is mounted inside the aircraft) in this regard, and it will be able to detect sources of electromagnetic emissions and suppress them with the aid of active, passive, one-time or multiple-use equipment.

The installation of the V01R infrared system is being proposed, which is able to get a fix on the flashes of guided-missile launches at distances of several dozen kilometers (it will have spherical scan starting in 1999). The later expansion of its functions is planned not only in getting a fix on launches, but also detecting aircraft, tracking them and launching guided missiles against them (including against targets in the rear hemisphere).

Much attention in designing the Rafale was devoted to the problem of the interaction of the pilot and the aircraft. Four multifunctional indicators will be installed: a holographic indicator on the front glass with a field of view of 30 x 22°, a head-up display on the upper portion of the instrument panel and two color ones along the sides. The system includes an artificial-intelligence device that performs the selection of parameters for display. The pilot controls the aircraft with the aid of two mini-levers on which are located toggles and switches for controlling the principal on-board systems. The use of a speech control system is being proposed, as well as a helmet-mounted indicator and sight. The pilot will wear an anti-G suit with controlled pressurization to lessen the effects of large G-forces, while the back of his seat will be inclined backward some 32° (29° on combat aircraft).

The Rafale aircraft is armed with a built-in DEFA 791B 30-mm cannon and has 14 external hangers (13 on the Rafale M), on which various weaponry can be mounted in various combinations. For example, it can carry up to eight Mica air-to-air missiles when performing air-defense missions. The fitting of the aircraft with a pod using the Atlis fire-control system is planned for the use of the AS.30L guided missiles and BGL bombs. Pods with reconnaissance equipment can also be hung on the aircraft.

Methods of reducing the signature of the aircraft in the radar, infrared, ultraviolet and visible spectra are being researched—the aerodynamic configuration is being refined, and faceted forms are being studied (polyhedral shapes with a large number of planar surfaces of a certain orientation). The greatest significance will be assigned to the utilization of radar-absorbing materials and coatings, especially after the higher radar signature of the experimental Rafale A than the F-17, which has a ferrite coating, was ascertained at the last air and space show at Le Bourget. The possibilities for employing the metal coating on the windows of the cockpit and methods of reducing engine smoke are also being studied.

The operational feasibility of the Rafale aircraft should be no worse than the Mirage 2000, the labor-intensiveness of the maintenance of which is 10 man-hours per hour of flying time.

The firm of Dassault-Breguet asserts that the Rafale has as much maneuverability and controllability as the Soviet Su-27 aircraft. Its specialists are currently refining

the flight control system, which will make it possible to execute a maneuver identical to the "Pugachev cobra."

Some French specialists are assuming, at the same time, that the advantages of flight at stalling angles of attack will be displayed only in one-on-one intercept, but are lost in the more complex conditions of group aerial battle. The exceedingly rapid changes in the heading and angular spatial orientation of the aircraft cause the pilot to become disoriented and do not permit him to make a suitable evaluation of the aerial situation, and especially to make a precise determination of the enemy's location. It is moreover pointed out that access to stalling angles makes it possible to achieve very small radii of 360-degree banked turns, but at the cost of a sharp drop in speed. An aircraft flying at low speed and, consequently, having limited ability to react to changes in the situation, becomes easy pickings for an enemy just entering the battle and disrupting the prior duel between the two aircraft, as well as for air-to-air missiles.

The first of the five experimental Rafale aircraft should be ready in February of 1991, and the delivery of series-produced craft will begin in 1996. Production will end in 2009 after the building of 336 aircraft (250 ground-based and 86 carrier-based).

The first air force squadron will reach the stage of combat readiness in 1999. The operation of carrier-based aircraft will begin in 1997 on the aircraft carrier Foch, on which they will be used only as interceptors due to the limited takeoff mass (16.5 tons) when being launched by catapult. The standard combat load is five air-to-air missiles (three Mica and two Magique) with two wing tanks holding 700 liters apiece. The maximum load, including air-to-surface ordnance, will be realized in the operation of the Rafale M from the nuclear-powered aircraft carrier Charles de Gaulle starting in the year 2000.

Characteristics of the Rafale A and D Aircraft %

Data	Rafale A	Rafale D
Length of aircraft, meters	15.79	15.30
Height of aircraft, meters	5.18	5.34
Area of wing, m^2	47	46
Wingspan with missiles at tip, meters	11.18	10.90
Static thrust of engines in afterburner/non-afterburner modes, tons of force	2 x 7.3/2 x 4.9	2 x 7.5/2 x 5.0
Unit fuel consumption in afterburner/non-afterburner modes, kg/kilograms of force-hour	<2.0/0.85	1.75/0.875
Maximum takeoff weight, tons	20.0	19.5
Takeoff weight in air-defense fighter mode, tons	14.0	approx. 13.0
Mass of empty aircraft, tons	9.0	8.8
Maximum allowable weight of load on outside hangers, tons	—	6.0
Fuel reserve, tons	4.4	>4.0
Maximum speed at altitude of 10,360 meters, km/hr	2,100	2,100 (about Mach 2)
Maximum speed at low altitude without hangers, km/hr	1,480	1,480 (about Mach 1.2)
Maximum angular velocity of turn at optimal speed, degrees/sec	24	>20
Maximum operating G-forces	+9/-3.5	+9/-3
Radius of action, km:		
—in flight at altitude of 12,200 meters for intercept with 8 Mica missiles and 4 external fuel tanks (2 x 1,300 and 2 x 2,000 liters)	—	1,850
—in attack on ground targets in high—low—high altitude profile with 12 250-kg bombs, 4 Mica missiles, 3 external fuel tanks (1 x 1,700 and 2 x 1,300 liters)	—	1,090
Takeoff distance (meters) in configuration:		
—fighter	—	400
—strike aircraft	—	600
Speed of landing approach, km/hr	217	222

Memory-Improvement Technique Explained

91UM0807H Moscow AVIATSIYA I KOSMONAVTIKA in Russian No 2, Feb 91 (signed to press 13 Feb 91) pp 38-39

[Article by Candidate of Medical Sciences Major of the Medical Service S. Aleshin under the rubric "To the Pilot on Psychology": "Improve Your Memory"; conclusion from Nos. 7, 9 and 11 for 1990]

[Text] The Use of Mnemonic Science

Marcus Tullius Cicero—an eminent Roman orator—struck his listeners with speeches in which he presented an abundance of facts without using notes. The secret of this was surprisingly simple. In preparing for his speeches at home, he went from room to room "tying" the contents of the speech to their setting. He visually reproduced that path in the process of articulating it. The prepared provisions were successively extracted from the "rooms," thanks to which the speech gained harmony and logic.

Such methods for holding various information in the mind have received the name of "mnemonics" or "mnemonic science" (*mnemo* as translated from Greek means "I remember"). The non-ordinary nature of long-term memory (LTM) in relation to the readiness to reproduce information serves as their psychological foundation. One can single out its active realm, in which needed information is always accessible. It stores, for instance, your name, birthday, professional knowledge etc. But the greater portion of the LTM is located in a latent, as it were slumbering, state. Effort is required to extract information from it.

Mnemonic science, taking into account the use of the methods of memorization considered earlier, presupposes the creation of a fixed series of visual reference images and their permanent storage in active memory. It was the string of rooms with things in unaltered positions for Cicero. The memorization of their order performs the role of a rack on which the most diverse information is hung via the formation of associations (links). In reproduction, pulling on the reference image like a hook, one can easily extract the information associated with it from latent memory. The creation of solid ties forces the necessity of adhering to certain rules for effective imagination: the colorful and concrete nature of the scenes conceived, the presence in them of a moment of motion or action, and their lack of conventionality and emotional nuance.

The method used by Cicero was developed over hundreds of years before our time, and was known as the "method of putting things in places." But anyone could employ it successfully even today. Objects in your apartment, typical points of reference on a certain route, say, from your building to some passageway or the like could serve as points of reference. Even simpler is to memorize a chain of, for example, ten visual images, choosing corresponding pairs: one—rhinoceros; two—double-barreled shotgun; three—trident; four—turtle; five—glove; six—six-in-hand; seven—a seven-headed dragon; eight—octopus; nine—the ninth wave; ten—a ten-ruble bill.

Say you are afraid of forgetting to take necessary things with you on a business trip. Compose a list—the first thing is shaving accessories, the seventh your sport suit. Using your imagination, "couple up" the items in the list to the reference images:

1. A rhinoceros, squeezing cream onto a brush, soaps his snout and shaves off his stubble... 7. A seven-headed dragon rips up your suit. Before leaving the house, run mentally through the reference chain and convince yourself that everything you need is in the suitcase.

A mnemonic system based on a digit-letter code (DLC) has significantly greater capabilities. It includes a hundred verbal reference images (objects) with a strictly defined ordinal number, and makes it possible to record virtually any information in memory easily, including memorizing numbers. The words in the list are included in such a way that their first consonants code the digit for the ordinal number. One apt DLC has been suggested by S. Blinkin and P. Skobolev. A pair of consonants has been selected for each digit in it from 0 to 9 (Table 1).

Digit-Letter Code %

0	*n*	*m*
1	*g*	*zh*
2	*d*	*t*
3	*k*	*kh*
4	*ch*	*shch*
5	*b*	*p*
6	*sh*	*l*
7	*s*	*z*
8	*v*	*f*
9	*r*	*ts*

The letters are either consonant with the corresponding numbers—*nol* [zero] to *n*, *dva* [two] to *d* and *t*, *chetyre* [four] to *ch* and *shch*, *pyat* [five] to *p* and *b*, *shest* [six] to *sh*, *sem* [seven] to *s* and *z*, *vosem* [eight] to *v* and *f*—or are somehow similar in written form: *g* to 1, *k* to 3, *r* to an upside-down 9 [in the Cyrillic alphabet]. The remaining consonants require conventional memorization.

The first nine words are selected for the list in such a way that they are composed of one consonant, indicating the ordinal number. Number 1, for example, is *yezh*. Starting with the tenth word, the number of consonants in a word may differ, but the first and second consonants should signify the tens and units respectively. Say *GuS* is number 17, while *SPrut* is 75. Three consonants should correspond to the ordinal number 100. This requirement is well met by the word *GNoM*.

We can compose one version of a verbal-numerical list in accordance with the rules enumerated (Table 2).

%

1.	*yezh*	21.	*dozhd*	41.	*chizh*	61.	*luzha*	81.	*fuzher*
2.	*ad*	22.	*dyatel*	42.	*shchit*	62.	*lodka*	82.	*vedro*
3.	*yak*	23.	*dikar*	43.	*shchuka*	63.	*shkaf*	83.	*fakir*
4.	*chay*	24.	*tucha*	44.	*chashcha*	64.	*leshch*	84.	*ovcharka*
5.	*Ob*	25.	*duplo*	45.	*shchup*	65.	*lupa*	85.	*vepr*
6.	*aul*	26.	*televizor*	46.	*chashka*	66.	*shlyapa*	86.	*vilka*
7.	*osa*	27.	*doska*	47.	*chasy*	67.	*los*	87.	*vaza*
8.	*iva*	28.	*tvorog*	48.	*shchavel*	68.	*lev*	88.	*fufayka*
9.	*yaytso*	29.	*trost*	49.	*chernila*	69.	*shar*	89.	*vor*
10.	*ogon*	30.	*kon*	50.	*banya*	70.	*sneg*	90.	*rama*
11.	*"Zhiguli"*	31.	*kozha*	51.	*Pegas*	71.	*sigara*	91.	*rog*
12.	*gudok*	32.	*kot*	52.	*botinok*	72.	*set*	92.	*rot*
13.	*zhuk*	33.	*kukhnya*	53.	*bokser*	73.	*sakhar*	93.	*rak*
14.	*Zhuchka*	34.	*Kashchey*	54.	*bochka*	74.	*sachok*	94.	*ruchey*
15.	*gepard*	35.	*kapkan*	55.	*buben*	75.	*sprut*	95.	*tsaplya*
16.	*zhelud*	36.	*kulak*	56.	*pushka*	76.	*slon*	96.	*resheto*
17.	*gus*	37.	*koza*	57.	*postel*	77.	*soska*	97.	*roza*
18.	*gvozd*	38.	*kofta*	58.	*pavlin*	78.	*sova*	98.	*rif*
19.	*garazh*	39.	*kuritsa*	59.	*Buratino*	79.	*syr*	99.	*tsar*
20.	*dom*	40.	*chaynik*	60.	*lom*	80.	*fonar*	100.	*gnom*

This means of memorization becomes more effective if the figurative depiction of the words is placed to the right of the ordinal numbers and the visual series is solidly memorized.

Functional DLC systems are based on the ability to create mental videoclips. Their first subject could be the memorization of the gallery of reference images we have created. Imagine, for example that a *yezh* [hedgehog] (1) is crawling along the ground and sees a hole in it. He climbs in and falls to *ad* [hell] (2), where he sees a strange picture: the devils are roasting a *yak* [yak] (3) in the flames... on top of a *rif* [reef] (98) on a throne sits a terrible *tsar* [czar] (99) over whom is fawning a small *gnom* [gnome] (100). You can imagine the middle yourself.

The problem, however, is to have the corresponding image arise in the consciousness automatically when addressing a certain ordinal number, like the answers in a learned multiplication table. Several weeks of daily practice are required for that. Those who want to can always find 10-15 minutes of free time.

We will consider the application of the DLC system to keep information of various types in memory.

Everyday information. The system is especially convenient for memorizing information that is not logically connected, the type we encounter most often in everyday life. Single out, for example, the ordinal numbers from 1 through 20 for purchases in the store, 21 through 40 for what to take on a business trip, 41 through 60 for planning domestic affairs etc. And if you have to go to the store, compose a list of purchases and link it with the assigned portion of the visual list. Say the 11th position is occupied by cheese. Imagine that you walk up to a *"Zhiguli"* [Zhiguli automobile] (11), open the hood and, instead of the engine, find a piece of cheese of the required weight there...

Business information. The principal elements of a coming telephone discussion, a list of business for the day, a superior's instructions, tasks for subordinates, topics for speaking at a meeting and the like—all this information, after its conversion to visual form, is well "coupled" to the reference images. The DLC system is a notebook that is always present in your head.

Numerical information. Say you are told the telephone number of an organization—68-37-25—but you have no pen. The DLC system comes to the rescue. Imagine that a *lev* [lion] (68) is chasing a *koza* [goat] (37) that jumps into the *duplo* [hollow] (25) of a tree. This picture is firmly preserved in memory, at least until you find a pencil and paper.

Or another example. Preparing for a test, you have to memorize that the average aerodynamic chord of an aircraft wing is 2.15 meters. Imagine a scene where the

chert [devil] in *ad* [hell] (2) with a decimal point in hand is training a *gepard* [cheetah] (15).

Dozens of numerical values of constants and parameters—including the calendar for the current year—convenient for various life and business situations, can be held in memory using a similar method. A section of the series corresponding to the number of months, say numbers 21-32, is used for this. The dates of the first Sundays in the months are translated into the images from the first seven numbers in the DLC system that correspond to them, which are in turn coupled with the allotted 12 reference images. October, say—the tenth month of the year, for which the *kon* [horse] (30) has been defined. The date of the first Sunday in October is the sixth, which corresponds to the image of the *aul* [Caucasian mountain village] (6). We compose a mental picture of you bursting into an *aul* on a galloping horse. If we need to establish what day of the week October 29 is, the visual association shows the date of the first Sunday of the tenth month, and from that we compute that it will be a Tuesday (6 + 21 = 27; 27 + 2 = 29).

The assimilation of teaching information, the memorization of contextual reference points when reading difficult texts, a sequence of actions when operating aircraft equipment etc. can all be organized in analogous fashion.

Our course is ended. Those who, rather than just getting acquainted with the enumerated recommendations, apply effort to their practical application will gain doubly. An improvement of memory will occur as a result of the development of your powers of observation, thinking and imagination as well.

Methods and devices for the rapid and solid memorization of information are part of the intellectual culture of a person, to the mastery of which it is desirable that more attention be paid in the course of professional training of aviation specialists.

Possible Loss of Aircraft Control in Banked Turns Studied

91UM0807I Moscow AVIATSIYA I KOSMONAVTIKA in Russian No 2, Feb 91 (signed to press 13 Feb 91) p 39

[Unattributed article under the rubric "Aviation Practicum": "Is There a Way Out?..."]

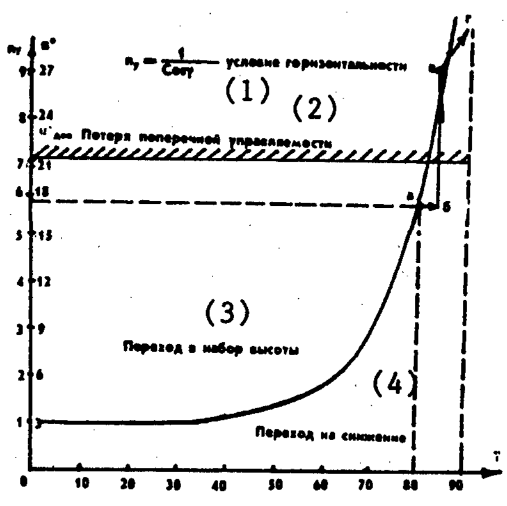
[Text] It is well known that the contemporary aircraft possesses increased reactions to slip in a roll with a simultaneous drop in the effectiveness of lateral control at large angles of attack. With the surpassing of the permissible angle of attack, which could be less than the critical one, the destabilizing moment becomes greater than the controlling one at the maximum setting of the ailerons; the effect of a reverse reaction to the rudder appears, and the aircraft spins in the opposite direction to the setting of the stick. The reason is the shadowing of the ailerons by the wing and the negative effect of the moment of yaw, which arises on the dropping half-wing as the result of the additional resistance with the setting of the aileron against the rotation and the increase in the angle of attack. Slippage and the moment of roll, impeding the recovery of the aircraft from the spin, arise on the rising half-wing.

The aircraft, when executing a turn on a horizontal plane with neutrally positioned ailerons, continuously increases its bank due to the kinetic rotation and the effects of the spiral moment. In order to hold it steady during the maneuver, the stick should be set somewhat in the direction opposite the bank.

A precise combination of banking and G-forces (angle of attack) is required simultaneously in order to maintain horizontal position (constant altitude) (see figure).

Let us suppose that the pilot performs a sustained 360-degree turn at the lowest possible altitude with a bank of 80°, that is, at 5.76 Gs (point *a*). He is distracted for a moment, and the bank increases by 5° (section *ab*); the aircraft moves into descent, and the threat of collision with the ground has appeared.

The pilot, in order to avert loss of altitude without reducing the bank (which is now his error), increases the G-forces to 9 (the angle of attack became greater than allowed) and enters the zone of reverse reaction to the rudder (section *bc*). The situation then gets out of control—attempts to reduce the bank through the full setting of the rudder, as well as increasing the G-forces to recover from the descent, increase the rotation (section *ad*). The attempt to reduce the angle of attack without



Area of executability of 360-degree banked turns

Key:
1. $n_y = 1/\text{Cos}\gamma$ - term of horizontal position
2. loss of lateral controllability
3. transition to gaining altitude
4. transition to descent

restoring controllability accelerates the loss of altitude. Is there a way out of this situation?

Prospective Propulsion Systems for Space Flight Viewed

91UM0807J Moscow AVIATSIYA I KOSMONAVTIKA in Russian No 2, Feb 91 (signed to press 13 Feb 91) pp 40-41

[Article by Yu. Zaytsev, a department head at the USSR Academy of Sciences IKI [Institute for Space Research], under the rubric "Problems of Space Science": "To Mars Under Sail?"]

[Text] *Unmanned interplanetary stations have long been traveling across the solar system. The question of organizing a manned expedition to Mars, with the landing of cosmonauts on its surface, is now being discussed. Specialists are today re-interpreting the terms of long-range space flights and the scientific and engineering issues, without whose resolution interplanetary flight by man will be impossible. One such problem is the choice of a power plant for the spacecraft.*

The gravitational effects of planets have already been utilized more than once by Soviet specialists to produce changes in the trajectories of space vehicles. The field of Venus directed the Vega-1 and Vega-2 unmanned spacecraft toward the comet Galileo as they flew by. The gravity of Mars will play the role of a trampoline in the plans for the Vesta project (the asteroid research program), "hurling" the spacecraft into the asteroid belt between the orbits of Mars and Jupiter. The Tsiolkovskiy project envisages putting an unmanned probe onto a flight trajectory toward the sun by employing a maneuver with the gravitational field of Jupiter. This will provide an opportunity of conducting research in the closest environs of our solar body.

The use of the gravity of planets makes possible a substantial economy of rocket fuel and a significant increase in the payload of spacecraft. The problem of interplanetary flights, however, cannot be solved entirely in this manner. An expedition to Mars, for example, will require such large reserves of fuel that the initial mass of the vessel in near-Earth orbit would be several thousand tons. And the deeper a person goes into space, the more problematic becomes the use of rocket engines operating on chemical fuels. Nuclear power sources are considered to be more efficient for this purpose. They create the quantity of heat that ensures a reactive thrust. Such engines are two or three times more economical than liquid-fueled ones.

Nuclear electroreactive engines are even more efficient. They are subdivided by principle of operation into electrothermal, electromagnetic and electrostatic engines. The latter are the most promising. One was tested for the first time on the Soviet Voskhod spacecraft in 1964. An electromagnetic (plasma) rocket engine was also tested on the Kosmos-728 in the USSR in 1975.

The electrostatic engine is also called an ion engine. Its principle of operation has the working medium (cesium, rubidium, mercury, argon or other elements) first subjected to ionization, and then the ions formed are accelerated in a powerful electrostatic field to speeds of tens and hundreds of kilometers a second, which makes it possible to develop an exceptionally high unit thrust pulse.

Thermal energy is transformed into electrical energy in nuclear electroreactive engines, and that is used in turn to create an electrostatic field. Some 15-20 times less of the working medium is required in such installations than the amount of fuel for liquid-fueled engines. They have serious drawbacks as well, however. The most substantial is that it is still impossible to achieve satisfactory thrust power.

The contemporary ion engine will be able to develop it to a magnitude of one kilogram at best. There is, of course, no point in thinking about using it for a launch from Earth. Separated from the liquid-fueled launch vehicle in space, however, it "comes into its own."

Plans for spacecraft with thermonuclear rocket engines are also being considered. The initial mass of the apparatus with a nuclear power plant in a flight to Mars, for example, should be five times more than its ultimate mass, while the initial and final masses in the utilization of the thermonuclear rocket engine can differ by only 15 percent.

Work was underway on a preliminary design in the Soviet Union as early as 1960-61. The necessary conditions for the realization of this idea, however, did not exist at the time. The situation is different today. The results of research have been published in a number of countries recently, and in Japan in particular, that confirm the possibility of implementing a thermonuclear reaction with a collision of bodies at a speed of 180 km/sec. Another plan proposes blasting microtargets—granular deuterium fuel with a mass of thousandths of a gram—with laser beams.

It should be noted that spacecraft with a thermonuclear rocket engine could have as much power autonomy within the bounds of the solar system as is obtained today in the world's oceans by surface ships and submarines fitted with nuclear installations. A high comfort level is achieved in flight therein, since such an engine provides for movement with acceleration and, consequently, eliminates the negative effects of weightlessness. Vessels of this type will make it possible to study the most distant reaches of the solar system, and with time to complete interstellar flights as well. They could attain speeds of ten percent of the speed of light.

Another engine of tomorrow is the solar sail. We know from our school days that solar light exerts a pressure. A famous experiment by Russian physicist P. Lebedev,

done in 1899, showed that the blades of a whirligig on an instrument he had created turned under the effects of the rays.

In 1920 F. Tsander expressed the idea of interplanetary flight with the aid of a solar sail—a mirror. This idea has not since ceased to attract scientists with its comparative simplicity and promise to provide maneuverability capabilities for spacecraft without substantial power expenditures. The solar light, it is true, is quite "weak." It presses against the sail with a force of just a few grams. But since it will constantly speed up the movement of the vessel, it will push it to second space speed over just a month.

What does the solar sail look like?

According to one of the projects, 12 lobes with a total area of 600,000 m^2 are deployed at a distance on the order of 100,000 kilometers from Earth. They are manufactured of aluminized plastic two and a half microns thick. Each is 6,250 meters long and eight meters wide. The gigantic surface, turned toward the sun, serves as the engine for the spacecraft. One can race a spacecraft on a spiral trajectory around the Earth and enter interplanetary space through the intelligent control of the solar sail.

The solar sail is most effective in flights in the direction away from the sun, but, like the ocean sailor, it can also sail against the "wind" toward the sun. The creation of such apparatus is felt to be entirely realistic at the contemporary level of development of engineering and space technology, since the production of the superfine polymer films necessary for the manufacture of the solar sail itself is at a high enough level. The first flights of the space sailors will evidently take place in 1993. They are timed to coincide with the 500th anniversary of the discovery of America by Christopher Columbus. The route is the Earth to the area of the moon, and then on to Mars.

The expedition is planned using three solar sailing vessels—the number of Columbus' boats. They are being created on different continents. This is also a symbol connected with the expedition of the discoverer: its organization and start were in Europe, its goal was Asia and its outcome was America. The principal technical parameters of the space "caravels" have been studied. Each of them should weigh 500 kg. The minimum sail area is several thousand square meters, with the creation of a pressure on it of about five grams.

The vessels should be ready for launch into geostationary orbit by 12 Oct 91, whence they will depart on solo "navigation." It is approximately 380,000 km from the Earth to the moon. The solar vessels will have to cover a path of about 50 million km, rounding the Earth several dozen times at ever increasing orbits so as to reach the orbit of the moon in a year.

But what happens when the time comes to go beyond the limits of the solar system? One cannot use such a sail to fly to the stars, after all; the further from the sun it is, the weaker its rays. There is a way out nonetheless. The sails of the interstellar craft could be filled with the energy of radio waves. They, like light, also "push," and moreover more strongly at lower wavelengths. But even in the most powerful band of radio waves—in the submillimeter band—their energy is hundreds or thousands of times weaker than light. The radio sail should thus have very large dimensions and be comparatively light. This can be done using a thin lattice by "perforations."

The "radio wind" for the sail will create a so-called maser—a molecular, or else quantum, generator of superhigh-frequency radio waves. It operates according to the same principle as the laser, but the emissions band—microwave—is different. It is being proposed to place it in near-Earth orbit, and provide energy from a solar electric-power space station. The plans are currently in the development stage.

The radio sail, despite all of its advantages, is nevertheless inferior to the ion engines. That is because its concept is based on technology that is as yet untested. The power of the maser emissions should be 20 million kW [kilowatts], *i.e.* roughly the equivalent of five Bratsk hydroelectric power plants, in order for the radio waves to "push" the sail. That is why, in the opinion of scientists, the ion engine is the first candidate for the role of an engine for spacecraft on flights not only within the solar system, but outside the bounds of it as well.

Soviet specialists have calculated the flight trajectory for space probes equipped with ion engines to reach orbit around the stars closest to the sun, Epsilon-Eridana, Tau-Kita, Epsilon-Indeyets and Barnard's star. How will a probe fly, say, to Barnard's star?

The whole route can be hypothetically divided into three stages. The first concludes at the place where the sun's field of gravity effectively disappears. A probe, as calculations have shown, would have to accelerate continuously to a speed of 9,500 km/sec in order to cover that part of the trajectory, 60,000 astronomical units in length (one astronomical unit [AU] is equal to the average distance between the Earth and the sun). That would take 60 years. The second leg of the trip is the galactic cruise. It makes up about 80 percent of the route. When only 17 AU remain to Barnard's star, the effects of its gravitational field will begin to be felt on the craft. The continuous braking of the probe will be required under its influence in the third section of the trajectory, which will take 30 years. The total distance from the sun to Barnard's star is 380,000 AU. Estimates have shown that the time for the flight of the probe to that star, depending on the flight parameters selected, will total 190-290 years.

Those who relegate such a flight to the realm of science fiction are in error. Matters are quite the reverse. The problems, of course, need not be oversimplified; specialists in space science will have to seek answers to many questions. But a flight to Mars is already on the agenda today. The preparation of the scientific and technical

base necessary for the start of work on accomplishing a manned expedition to that planet is one of the goals of the state "Mars" program that is being realized in the Soviet Union today. And there will be trips to other regions of the solar system, and beyond it, after a Martian flight. This is not only a scientific and engineering issue, but an issue of progress for civilization on Earth.

Kvant-2 Spacecraft Described

91UM0807K Moscow AVIATSIYA I KOSMONAVTIKA in Russian No 2, Feb 91 (signed to press 13 Feb 91) pp 46-47

[Article by G. Glabay under the rubric "On the Road to a Space Factory": "The 'Kvant-2'"]

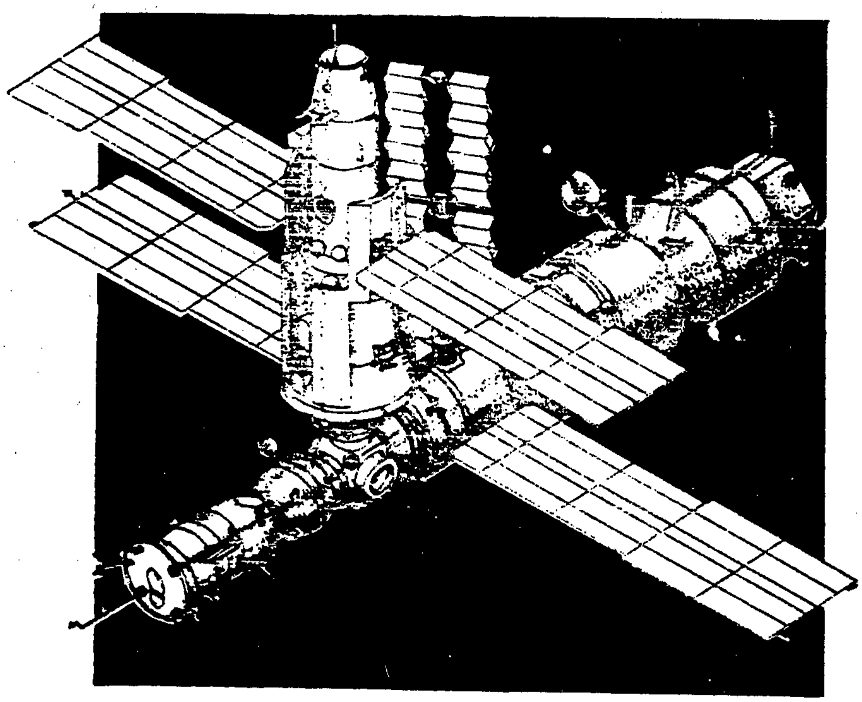
[Text] *The Mir space station—the base unit of a now permanently operating space complex—was launched into near-Earth orbit on 20 Feb 86. Our readers I. Ibragimov (Petropavlovsk), Ya. Genne (Poland), M. Postukhov (Alma-Ata) and S. Gruyitsa (Yugoslavia), among others, ask that we talk about its later modules, the Kvant-2 and the Kristall.*

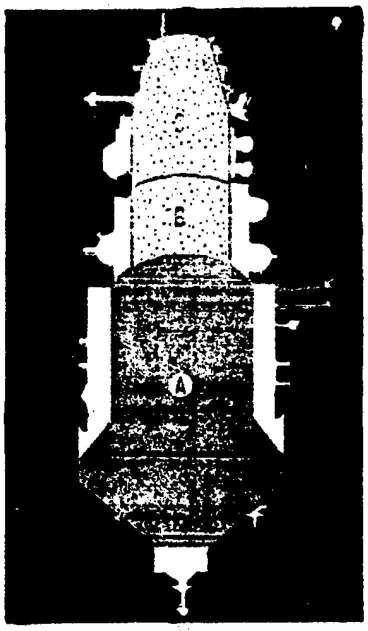
The orbital complexes are one of the most important areas of Soviet space science. And we have a right to be proud of the fact that our country today has engineering at its disposal that makes it possible to perform experiments in space for up to several months, even years, at a time. The launch of the first Salyut orbital space station on 19 Apr 71 was the beginning.

Those stations, five of which were put into orbit, had just one docking assembly and could receive just one spacecraft. All of the scientific gear and consumables were moreover put aboard the station before launch, which limited the overall time for its operation and the length of time cosmonauts could remain on board. The maximum time of manned flight that was achieved on those stations was 63 days. All of this also defined the strategy for the later development and utilization of the research laboratories for national-economic purposes. The more advanced Salyut-6 and -7 stations, with two docking assemblies, came later.

The third-generation Mir station was significantly superior to its predecessors in design and technical sophistication. Fitted with a new system with six docking assemblies, it is the base unit for the building of a multipurpose manned complex with specialized and unmanned cargo vessels. The pages of AVIATSIYA I KOSMONAVTIKA No. 11 for 1986 and Nos. 2 and 4 for 1989 described the specific features of its design and operation as part of the Mir—Kvant-1—Soyuz TM orbital complex.

The makeup of the complex was supplemented by the latest Kvant-2 module on 6 Dec 89. We note that its docking from an axial angle on one of the four lateral docks was accomplished for the first time using a powerful mechanical claw—the so-called manipulator installed on the module itself. All of the docking operations, which took about an hour, were performed on command from the TsUP [flight-control center]. These new achievements in domestic space science, however, remained unnoticed by many. We have for some reason begun to be ashamed of our successes against the background of the ever-worsening economic situation. Certain authors, both here and abroad, have taken every





Compartments of the Kvant-2:

Key:
A. cargo-instrument compartment
B. scientific-instrument compartment
C. special airlock compartment

opportunity to try and diminish the achievements of Soviet space science, as well as call into question the priority of the flight of the first cosmonaut on the planet, Yu. Gagarin. That is why it is namely the duty of every participant in these events not to stand idly by during these troubled times for the country, but to speak up determinedly against all attempts to falsify the history of space science. But, to return to the topic of this story, what are the purpose and design features of the docked module?

The Kvant-2 was designed and developed as a constituent element for resupplying the Mir orbital complex with equipment, apparatus, fuel reserves and consumables. This "accessory" made it possible not only to relieve the base unit and perform the reconfiguration of the scientific gear, but also to provide greater convenience in the control of on-board equipment and comfort for the crew. The design itself and the module's on-board systems were selected proceeding from the scientific tasks that would have to be resolved in space. The capabilities of the complex in providing life support for the crew and electric power or reductions in "nonscientific" cargo traffic such as, for example, the delivery of reclaimers for oxygen in the air, were thereby expanded.

The scientific gear has been supplemented with the MKF-6MA kit for multiple-zone photography, the Inkubator-2 biological system to devise a technology for raising birds in weightlessness, the specialized ASP-G-M platform and other equipment. A system for the autonomous movement of the cosmonaut (SPK) has been installed on board for the performance of operations directly in outer space.

A few words regarding the structure of the resupply module. The Kvant-2 consists of three airtight compartments—cargo-instruments (PGO), scientific-instruments (PNO) and special airlock (ShSO). The principal portion of the equipment and delivered cargo are placed in the first of them, housed in containers and fastened to panels on its "floor" and "ceiling." The so-called backup equipment (film canisters, ampules with biological drugs and the like), as well as spare parts, tools and accessories for on-board systems, are here in standardized containers. Those of them that are freed up are used for waste and unloaded onto cargo vessels. The breathing apparatus (not in the system before), washroom and water reserves should assist the cosmonauts in maintaining good sanitary and hygienic conditions. The PGO also contains control panels for the life-support systems.

Also housed in the scientific-instrument compartment, aside from the aforementioned MKF-6MA and Inkubator-2, are a chamber for animals, a container for transporting birds, a monitoring and control panel and an air-duct container. Its central portion has two lights, on one of which is installed a camera, while the other serves for visual monitoring of the conditions for photography and the performance of experiments. The pressurization and gyrodyne systems are located in its external portion.

The configuration of the ShSO includes all of the necessary equipment and tools for working in open space—the SPK, a pair of Orlan-DMA space suits, umbilical tethers and electrical cords and a KAP-350 camera for working in conjunction with the Priroda-5 system. The replacement of power supplies, refilling of air tanks and checking of the SPK systems is also performed there. A remote-control video-spectral system has been attached to the outside of the special airlock compartment for the first time. A dedicated apparatus (black-and-white and color television cameras, an infrared spectrometer, an X-ray emissions analyzer and a MKS-M2 multiple-zone spectrometer) and a control system have been installed on the automatically stabilized ASP-G-M platform. The system is intended for the performance of scientific research and experiments requiring the detection, guidance and tracking of surveillance targets on the Earth's surface.

A depiction of the Kvant-2 module would clearly be incomplete without mention of the specific features of its functioning as a part of the newly built Mir orbital complex (with an overall mass of about 67 tons and length of 26 + 14 meters).

The apparatus of the engine-control system that has been installed in the module, operating in conjunction with the apparatus of the base unit of the complex, thus

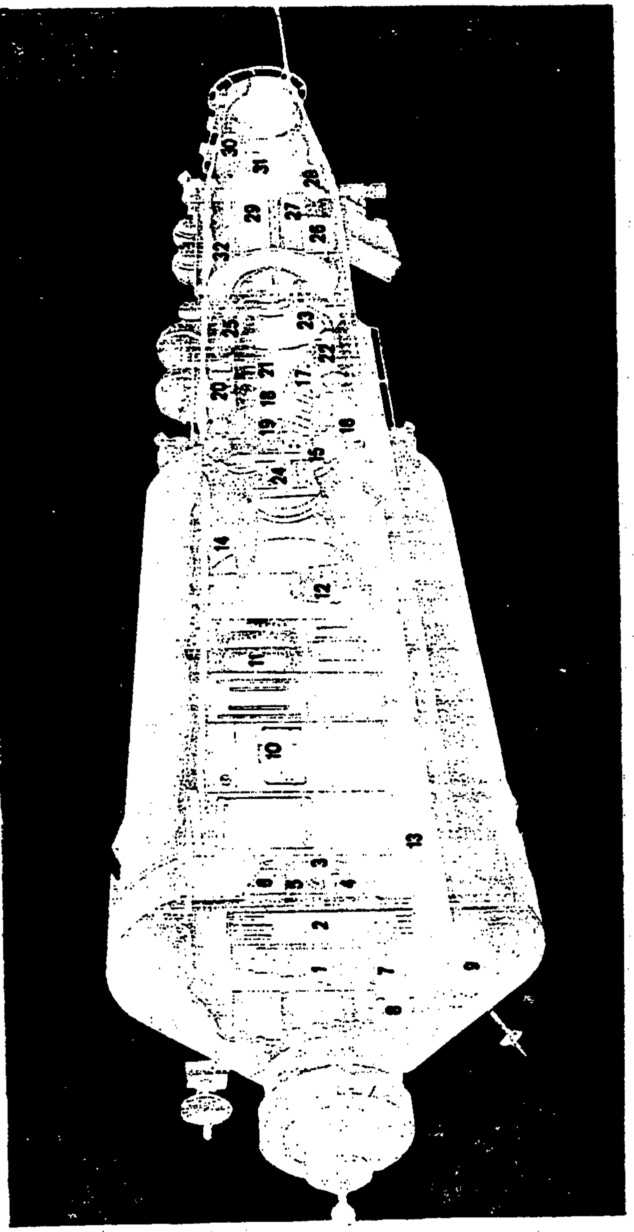


Diagram of module systems:

Key:
1. shower
2. curtain
3. washroom compartment unit (supplied on the Progress M spacecraft)
4. monitoring and control unit
5. command-processing unit
6. automated equipment
7. liquid and solid waste receptacle
8. IPK-1 instrument (3)
9. control station
10. accessories for Rodnik system
11. portable pressurization unit (supplied on the Progress M spacecraft)
12. water tank
13. handholds
14. PGS-PNO hatch cover
15. charging assembly
16. lighting
17. MKF-6MA photographic system
18. animal chamber
19. monitoring and control panel
20. Inkubator-2
21. bird-transport container
22. air-ducts container
23. air ducts
24. panels
25. PNO-PShO hatch
26. Orlan-DMA pressure suit (2)
27. stowage for umbilical cord
28. absorption cartridges
29. cosmonaut movement system (SPK)
30. fan
31. electrical cord (20 meters)
32. SPK holder

performs the tasks of orientation, stabilization and navigational support. The gyroscopic power stabilizers—the gyrodynes—act as the operative elements of this system. Their rotating flywheels become the "point of reference" in relation to which the whole orbital complex can now be turned. Recall that gyrodynes do the same thing as jet engines in an orientation system—they create the controlling moments for rotation, but without the expenditure of fuel.

The engines for docking and stabilization of the module support the organization of joint functioning of the operative elements of the complex and module from the engine-control systems of the base unit. They also create the controlling moments when it is located at a lateral docking assembly of the base unit of the orbital complex.

The electric-power supply system not only supports the module's systems, but also takes part in raising the power ratio of the whole system. It is based on two solar panels and six 800A battery units with charging and discharging apparatus. The orientation of the former is performed automatically through turning around its own longitudinal axis.

External gear provides information on the outside situation. It confirms operability and monitors the thermal regulation of the coating ("Epsilon"), determines meteorite streams and assesses their penetration capability (MMK-1), and records the effects of outer space on electrical and radio elements and composite and structural materials ("ERE" and "Komplast") in real-time mode.

And that is not all. The standardization of systems (docking and internal transfer, automatic docking, checking of airtightness and airflow, control of on-board systems and pressure-regulation equipment, as well as the radio and telemetry systems and television communications) on board the station ensures the reliable functioning of the module as part of the Mir orbital system. It was put into orbit by the Proton launch vehicle.

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